

APPENDIX A

DE MINIMUS CALCULATION

In accordance with methodology prescribed by Appendix A of the DOE Mass Balance Project Plan,¹ calculations were performed to estimate for each of the various process streams the additional dose presented by constituents in irradiated uranium over that of the uranium itself. The DOE EH-3 team provided a standardized tool, in the form of an electronic spreadsheet prepared specifically for the purpose, to perform the dose fraction calculations. The calculation and its technical basis are described in detail in the Project Plan, and an example of the output from the tool is shown in Figure A-1. To use the tool, the following information about the process stream being considered must be determined and entered into the spreadsheet:

- chemical form (e.g., UF₆)
- level of enrichment in the ²³⁵U isotope
- mass fraction of the constituents ²³⁸Pu, ²³⁹Pu, ²⁴⁰Pu, ²³⁷Np, ²⁴¹Am, ²³⁶U, and ⁹⁹Tc

The required information was determined by assuming estimates based on available analytical data, process knowledge, and engineering judgment. Calculations were performed for the streams of interest as identified in the flow diagrams in Appendix B. Assumptions for and results of the stream calculations are summarized in Appendix B.

A result of <0.1 indicates that the additional dose presented by the RU constituents is less than 10% of that of the uranium itself. RU streams characterized by a dose fraction of <0.1 were deemed *de minimis* in accordance with the definition established for the Recycled Uranium Mass Balance Project. For those streams, the radiation-protection measures in place for the presence of uranium are considered adequate for worker protection.

Figure A-1 Example Output of RU Dose Fraction Calculator

Chemical Forms of Uranium					
Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCI4	0.63	UO2(NO3)2	0.6

U Enrichment (% U-235) =	<input type="text" value="0.64"/>	U SpecAct uCi/g U	3.60E-01	Ratio	
Chemical Form of U code =	<input type="text" value="0.83"/>	DAC Value	3E-10	Act to DAC	1.20E+09

SUM Constituent Act to DAC=	3.90E+08	Fraction Dose from Constituents =	0.3254
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Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238	<input type="text" value="0.00E+00"/>	0.00E+00	3.00E-12	0.00E+00
Pu-239	<input type="text" value="0.00E+00"/>	0.00E+00	2.00E-12	0.00E+00
Pu-240	<input type="text" value="0.00E+00"/>	0.00E+00	2.00E-12	0.00E+00
Np-237	<input type="text" value="0.00E+00"/>	0.00E+00	2.00E-12	0.00E+00
Am-241	<input type="text" value="0.00E+00"/>	0.00E+00	2.00E-12	0.00E+00
U-236	<input type="text" value="0.00E+00"/>	0.00E+00	3.00E-10	0.00E+00
Tc-99	<input type="text" value="0.00E+00"/>	0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	<input type="text" value="3.76E-05"/>	3.00E-12	1.25E+07
Pu-239	<input type="text" value="2.55E-04"/>	2.00E-12	1.28E+08
Pu-240	<input type="text" value="5.99E-05"/>	2.00E-12	3.00E+07
Np-237	<input type="text" value="3.67E-04"/>	2.00E-12	1.83E+08
Am-241	<input type="text" value="0.00E+00"/>	2.00E-12	0.00E+00
U-236	<input type="text" value="1.10E-02"/>	3.00E-10	3.67E+07
Tc-99	<input type="text" value="1.33E-01"/>	3.00E-07	4.42E+05

K-1131 Chemical Plant Stream 1 & 2	
Assume	
Pu ppb	4.4
Np ppb	520
Tc ppm	7.8
U-236 ppm	170
Assume UO3 @ .64 U-235	
Assume Weapons Pu Dist	
Pu-238	0.05
Pu-239	93.5
Pu-240	6
Pu-241	0.4
Pu-242	0.05

¹ U.S. DOE, *Historical Generation and Flow of Recycled Uranium in the DOE Complex*, February 2000.

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